hours. The hatching, like spawning, appears to be from a couple of hours before midnight to two or three hours after midnight. The developing eggs collected from plankton were straw coloured and unsculptured, with the characteristic single, large oil globule. The egg measured 0·677 to 0·732 mm. and the oil globule 0·292 to 0·347 mm. The newly hatched larva measures 1·519 to 1·556 mm. The myotomes are 24, the trunk myotomes forming 11 and tail myotomes 13 including the unsegmented terminal mesoderm. The larvae survived up to six days in the laboratory and the six-day old larva measured 2·342 mm.

The 'Dangla' fishery of Chilka Lake showed considerable fluctuations in the range 27-299 m. tonnes (Jhingran & Natarajan 1965) during 1957-1965 period and this is, in no small measure, due to vagaries in recruitment. As recruitment and egg production are related and as the breeding of 'Dangla' is around the lakemouth and inshore areas of sea proximal to lakemouth, it is to be emphasized that breeders should not be unduly exploited, as done now, particularly in the outer channel during November-January.

We are grateful to Dr. B. S. Bhimachar for evincing keen interest in these investigations and Dr. V. G. Jhingran for his valuable suggestions.

CENTRAL INLAND FISHERIES RESEARCH SUB-STATION[1], HAZARIBAGH,
January 4, 1969.

A. V. NATARAJAN
S. PATNAIK

REFERENCES

JHINGRAN, V. G. (1958) : Observations on the seaward migration of *Mugil cephalus* Linnaeus from Chilka lake for breeding. *Curr. Science* **27** : 181-182.

——— (1963) : Report on the fisheries of Chilka Lake (1957-1960). Bull. No. 1, Central Inl. Fish. Res. Inst., Barrackpore (India).

——— & NATARAJAN, A. V. (1965) : Final Report on the fisheries of the Chilka Lake (1957-1965). Bull. No. 8 Central. Inl. Fish. Res. Inst., Barrackpore (India).

17. OBSERVATIONS ON THE FOOD OF YOUNG *HILSA ILISHA* (HAM.) OF THE HOOGHLY ESTUARINE SYSTEM

(With a text-figure)

INTRODUCTION

The 'Indian Shad' *Hilsa ilisha* (Hamilton), forms a rich commercial fishery in the Hooghly estuary. Although considerable knowledge has been gained by various workers on the different aspects of the biology

[1]The investigations were carried out under the auspices of the Chilka Investigation Unit of Central Inland Fisheries Research Institute, Balugaon, Puri (Dist.), Orissa.

and fishery of the species (Pillay & Rosa 1963). Little work has been done on the food and feeding habits of juveniles of the species. Chacko and Ganapati (1949) have listed the different organisms that occurred in the stomach of the adult specimens of Hilsa from the coastal waters of East Godavari District (Andhra Pradesh). They found the stomach of 150 specimens, examined from the Godavari River, to be empty. Hora & Nair (1940 a, b), Pillay & Rao (1962) and Halder (1968) have worked on the food of young *Hilsa ilisha*. This study was undertaken with a view to ascertain the variations in the intensity of feeding as well as in the composition of food among the different size groups in different zones and in different seasons.

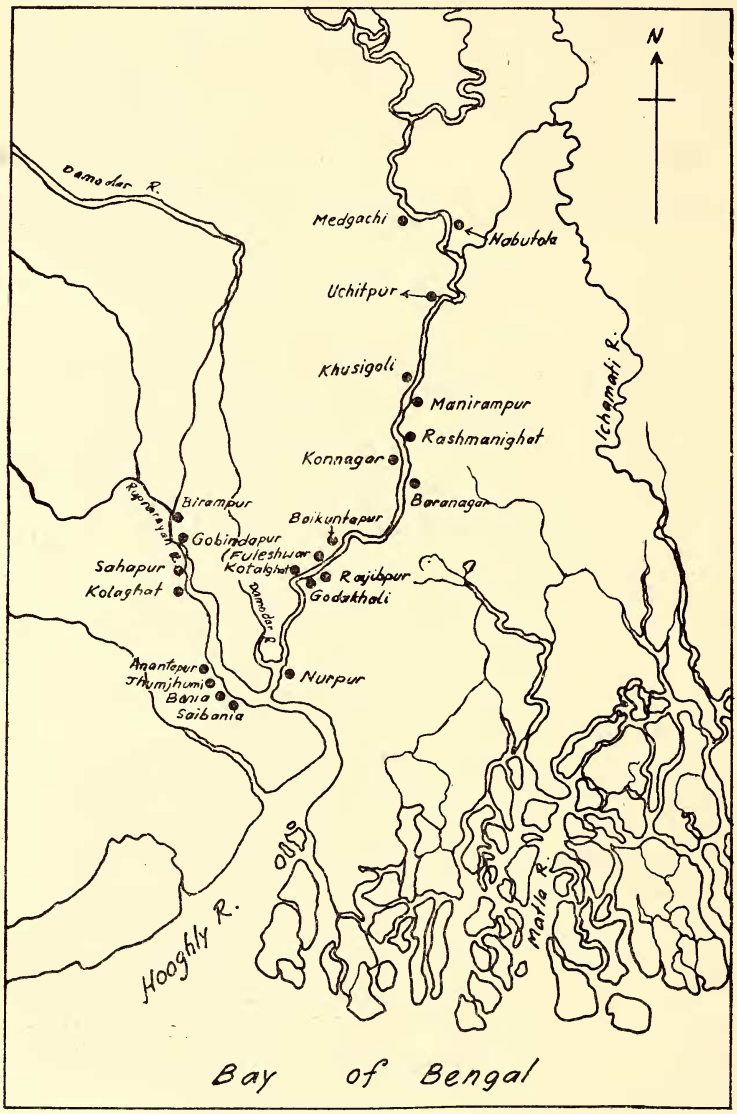
Material and Methods

The material for the present investigations was obtained from the River Hooghly and its tributary, the Rupnarayan. Regular fortnightly random samples were collected from 22 sampling centres (Text-fig. 1) for a period of three years, 1962-64. A total of 1640 specimens of *Hilsa ilisha*, in the size range of, 20 to 200 mm. total length were analysed. Total length was taken from the tip of the snout to the end of the lower lobe of the caudal fin. The fish, in fresh condition, were either directly obtained from Shore-seines (Chatberjal) and bag nets (Behundijal) or from local fish market. The specimens were preserved in 5% formaldehyde, and the stomach contents were analysed by the numerical method, i e. the total number of each food items was expressed as percentage of the total number of organisms present in the stomach (Hynes 1950 and Pillay 1952) for different years, zones and lengths. This method is considered as an improvement over other numerical method. In order to improve the accuracy of the analysis, a Sedgwick—Rafters' plankton counting cell was also used. From the gut contents, 1 cc. of random sample was uniformly taken in a sedgwick—Rafters' plankton counting cell, and individual species were identified and counted. When sand, debris and other unidentifiable materials (digested and semidigested) occurred in the guts, their respective percentages were recorded by eye-estimation method. The quantities of debris and unidentifiable matter were grouped in one as miscellaneous items.

Food Habits

As will be seen from Table 1, the young *hilsa* measuring 20-120 mm. in total length were observed to feed actively on zooplankton maximum 68% followed by average 50% phytoplankton in addition

to appreciable quantities of decaying organic matter and sand particles. Whereas, in fishes measuring 120-160 mm. in length, the food was



TEXT-FIG-1.

MAP OF THE HOOGHLY ESTUARINE SYSTEM ALONG WITH ITS TRIBUTARY THE RUPNARAYAN, SHOWING AREA OF INVESTIGATION AND COLLECTION CENTRES

mainly constituted by phytoplankton followed by zooplankton, decaying matter and sand particles. In specimens measuring 160-180 mm., neither zooplankton nor phytoplankton were encountered. But, since

TABLE 1

PERCENTAGE PREVALENCE OF VARIOUS FOOD ITEMS IN DIFFERENT CLASSES OR GROUPS

	2-4 cm. %	4-6 cm. %	6-8 cm. %	8-10 cm. %	10-12 cm. %	12-14 cm. %	14-16 cm. %	16-18 cm. %	18-20 cm. %
Zooplankton	68·18	44·65	54·26	55·65	52·54	19·32	20·00	..	48·20
Phytoplankton	10·78	24·24	5·83	6·39	12·80	27·10	42·73	..	15·90
Sand	6·99	12·22	3·98	6·91	4·75	7·00	4·32	50·00	..
Miscellaneous	14·05	18·89	35·93	31·05	29·91	46·58	32·95	50·00	35·90

TABLE 2

FLUCTUATIONS IN THE INTENSITY OF FEEDING IN DIFFERENT YEARS AND IN DIFFERENT ZONES

	1962			1963			1964		
	Zone I %	Zone II %	Zone IV %	Zone I %	Zone II %	Zone IV %	Zone I %	Zone II %	Zone IV %
Gorged	1·11	2·70	..	1·52	..	..	1·59	..	0·63
Full	1·82	12·68	..	6·64	1·82	1·09	1·93	..	0·74
¾ full	30·13	28·33	20·91	9·20	5·45	2·73	5·10	..	1·37
½ full	33·06	26·43	29·22	14·37	5·45	22·95	8·37	..	1·90
¼ full	9·12	12·12	24·94	16·05	2·22	3·28	11·13	12·50	9·36
Traces	7·94	8·06	8·31	16·41	6·67	50·55	8·45	..	4·45
Empty	16·82	9·67	16·62	35·81	78·39	19·40	63·43	87·50	81.54

in both the bordering classes (14-16 cm. and 18-20 cm.) zooplankton and phytoplankton were noticed in the guts, it is likely that their non-occurrence in this middle class (16-18 cm.) may be due to inadequate sampling. In the length range 180-200 mm., zooplankton formed the main food followed by debris and phytoplankton.

The zooplanktons encountered in the gut contents, in the order of their dominance, were copepods (*Calanus* and *Cyclops*), cladocerans (*Bosmina, Daphnia* and other *Cladoceran* eggs) rotifer (*Keratella, Monostyla* and *Keratella* eggs) and ostracods.

The following phytoplankters were encountered, mentioned in the order of their dominance: diatoms (*Coscinodiscus, Synedra, Cyclotella, Melosira, Pleunosigma, Gyrosigma, Surirell*), bluegreen algae (*Microcystis, Aphanocapsa, Oscillatoria*) and green algae (*Spirogyra, Pediastrum* and *Eudorina*).

The fluctuation in the intensity of feeding of the fishes (expressed as % of fullness of the gut) during the different years and different zones is shown in Table 2.

The peak intensity of feeding was noticed during the year 1962 in all the zones and the same pattern was observed to a certain extent in 1963 also. However, feeding was very poor during the year 1964, as the stomach was found empty in 77·82% and food materials in traces in 4·30% cases.

Discussion

Hora & Nair (1940 a, b), concluded that young *Hilsa* feed at the bottom as sand grains were encountered in the stomachs. Pillay & Rao (1962), inferred from their studies on *Hilsa* from Godavari estuary that the species is a bottom feeder during the entire period of its life, especially from 43 mm. stage onwards and they have also assumed that *Hilsa* feeds at all depths. Halder (1968), concluded from his studies on the food habits of young *Hilsa ilisha* in the freshwater zone (around Nabadwip) of the Hooghly estuary that the young ones of the species feed at all depths. The present study further confirms this observation not only in the freshwater zone but also in the tidal zone (up to Diamond Harbour) of the estuary where the young *Hilsa* feed at all depths.

It is evident from the above studies that the young of *Hilsa* is dominantly a zooplankton feeder up to 120 mm. in length followed by a dominance of phytoplankton in the next two size groups i.e. (120-160 mm.) and vice versa in size groups (180-200 mm.).

ACKNOWLEDGEMENTS

I am greatly indebted to Dr. V. G. Jhingran, Director, Central Inland Fisheries Research Institute, and Dr. V. R. Pantulu for their guidance and encouragement during the course of this investigation. My grateful thanks are also due to Shri P. Datta for valuable suggestions and Dr. V. Gopalakrishnan for critically going through the manuscript and Shrimati Surya Kumari Raju for analysing the gut contents.

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE,
BARRACKPORE,
August 2, 1969.

D. D. HALDER

REFERENCES

CHACKO, P. I. & GANAPATI, S. V. (1949) : On the bionomics of *Hilsa ilisha* (Ham.) in the Godavari. *Madras Univ. J.* **18** : 16-22.

HALDER, D. D. (1968) : Observations on the food of young *Hilsa ilisha* (Ham.) around Nabadwip, in the Hooghly estuary. *J. Bombay nat. Hist. Soc.* **65** (3) : 796-798.

HYNES, H. B. N. (1950) : The food of the freshwater sticklebacks (*Gasterosteus aculestus* and *Pygosteus pungitius*), with a review of methods used in the studies of the food of fishes. *J. anim. Ecol.* **19** (1) : 36-58.

HORA, S. L. & NAIR, K. K. (1940a) : Further observations on the bionomics and fishery of Indian Shad, *Hilsa ilisha* (Ham.) in Bengal Waters. *Rec. Indian Mus.* **42** (1) : 35-50.

——— (1940b) : The jatka fish of Eastern Bengal and its significance in the Fishery of the so-called Indian Shad, *Hilsa ilisha* (Ham.) *Rec. Indian Mus.* **42** (4) : 553-555.

PILLAY, T. V. R. (1952) : A critique of the methods of study of food of fishes. *J. Zool. Soc. India*, **1** (2) : 185-200.

PILLAY, S. R. & ROSA, JR. (1953) : Synopsis for biological data on the hilsa, *Hilsa ilisha* (Ham.) 1822. *Fao. Fish. Bio. Synops.* **25** : 64.

——— & RAO, K. V. (1962) : Observations on the biology and fishery of the Hilsa, *Hilsa ilisha* (Ham.) of River Godavari. *Proc. Indo-Pacific. Fish. Coun.* **10** (2) : 37-61.

18. THE FECUNDITY OF *HETEROPNUESTES FOSSILIS* (BLOCH)

(*With three text-figures*)

INTRODUCTION

Fecundity or the reproductive potential can be defined as the number of ova shed during a particular spawning season (Pillay 1954). The study of fecundity is important in the fishery exploitation, especially in freshwater fishes which are now bred artificially in impounded waters by injecting pituitary hormone. Since fecundity bears a definite relationship with total length, body-weight and ovary-weight of fishes,